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Transdisciplinary environmental research: building trust across professional cultures.

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Abstract

With the challenges of researching complex topics such as those related to environmental sustainability and land use, there is a growing interest in promoting collaboration between research and industry, between different disciplines in research, and between different types of research organisations. However there is a need to know more about how collaboration is operating and approaches to building trust in these relations. This paper uses the detailed analysis of 10 case studies of research collaborations related to sustainability and environmental land-use to examine the different professional cultures among research collaborators, the incentives they have to cooperate, and the processes of building trust. The paper shows that trust is vital when crossing professional cultural boundaries as people are opening themselves to vulnerability and risk. The results show how trust is built between university researchers, environmental NGOs, private businesses and commercial advisory companies. Trust is shown to be built by having information others, prior experience of working together, norms of cooperation, and sanctions exerted on those who might transgress norms of behaviour. Having incentives is a necessary but not adequate basis for having trust. These relationships are built up through existing relationships, building trust through progression of projects and the use of intermediaries or guarantors.

Key Words: Collaboration, trust, professions, land-use, sustainability, qualitative, interdisciplinarity, boundary.

1. Introduction

There are increasing calls for research that addresses complex environmental concerns to take interdisciplinary and transdisciplinary approaches, drawing upon research teams composed from different disciplines and professions. (Scott *et al*, 1999, Thompson-Klein, 2004, Donaldson *et al*, 2010, DEFRA, 2011, Podestá *et al*, 2010). This research takes place in a context of multiple competing values and objectives and uncertainty. It is argued this cannot be adequately addressed by mono-disciplinary scientists alone, but requires research which extends beyond science (Hochtl *et al*, 2006), thus including the social and policy context within which they are situated. With regard to public sector funded research there is a growing demand from the users of more applied research for activities that cross disciplinary and professional cultural boundaries in order to develop knowledge that can increase productivity, promote environmental benefits and ensure public sector funded research is more relevant to the needs of business (Lambert, 2003).

This paper explores the incentives to cooperate in research through a detailed analysis of ten case studies of agricultural sustainability and land use. Taking the collaborative project as the unit of analysis, the process of building cooperation for environmental research is explored with a focus on the development of trust between research actors. While there is considerable public investment in collaborative research projects across the world, the challenge remains to know more about the process of building, and more importantly sustaining, collaboration (Demeritt, 2005; Mauzet *et al*, 2012). Reflection on individual collaborative research projects once they come to completion provides valuable information (Bracken and Oughton, 2006; Jones and Macdonald, 2007; Podestá *et al*, 2012; Pohl, 2008; Romero-Lankao *et al*, 2011). However, this paper is able to examine the factors shaping the process of collaboration in research in more depth through comparative analysis of case studies. The different types of participants in collaborative research can result in very different incentives and challenges. The first research question is therefore: What are the different incentives and disincentives to collaborate? This research also shows that incentives on their own are not enough, and there is a need to understand the processes and relationships underpinning collaboration. This leads to the second research question: How is trust produced in collaborative research?

This paper contributes to debates on how to support collaborative inter and trans-disciplinary environmental science. The findings show how collaborative research projects need to understand issues of trust and power as people open themselves to greater risk and vulnerability while working outside their own organisation, outside their professions and when dealing with less tangible products such as 'knowledge creation' (Melin, 2000). Trust is shown to be based on information on other partners as well as sanctions. Underpinning these are profession-specific norms. This paper therefore contributes to knowledge by addressing the lack of understanding concerning how relationships that cross disciplinary and professional cultural boundaries are built.

2. Professional cultures and cross boundary relationships: towards a conceptual framework.

2.1 Crossing cultures and transdisciplinary collaboration

Collaborative research can go beyond crossing disciplinary boundaries (what is referred to as interdisciplinary research) to also include the crossing of narrow professional cultural boundaries between practice and research. This can be termed 'transdisciplinary' or participatory research (Lawrence and Depres, 2004) that

includes practitioners from a range of professions such as business, public service or the NGO sector becoming participants or collaborators in research; co-creators of knowledge (DEFRA, 2012).

The crossing of such boundaries is a particular issue in the environmental arena where the subject matter crosses boundaries of disciplines and professions. Scott *et al* (1999:4) found that “Environmental research has unique characteristics because it encompasses both social and ecological dimensions” and problems such as sustainability, people-environment relations, technology innovation and risk assessment are problems that require interdisciplinary approaches (Thompson-Klein, 2004) which are “scientifically robust” but also “socially relevant” (Romero-Lankao *et al*, 2011). Cortner (2000) suggests that the development of environment and natural resource management policy could be better achieved through embedding research within the perspective of policy and local actors.

This has resulted in a growing emphasis on encouraging sustainable collaborative innovation and building relationships between academic and non academic sectors, either through links between research and businesses, or research and practitioners in the field (Katz and Martin 1997; Bammer, 2008; Lowe and Phillipson, 2009; Podestá *et al*, 2012). Internationally, there has been a drive to promote interdisciplinary research¹ from research funders who in turn are under pressure from national governments to demonstrate research impact. Environmental NGOs are engaging in research through employing researchers in house, or commissioning / co-funding research projects.

Interdisciplinary and transdisciplinary research brings new challenges of its own. Communication between participants, differing terminologies, methods and conceptual approaches are all challenges faced as participants learn to cooperate across disciplinary and institutional divides (Mauz *et al*, 2012; Broto *et al*, 2009; Bracken and Oughton, 2006; Harris *et al*, 2009). Many interdisciplinary and transdisciplinary research projects pause to reflect on the process of research collaboration and some argue “co-reflection” among team members should be an integral part of such projects (Podestá *et al*, 2012; Roux *et al*, 2010). Such research has highlighted the importance of interdisciplinary and transdisciplinary teams learning to collaborate. Broto *et al* (2009) to refer to interdisciplinarity as a social practice. The review by Mauz *et al* (2009) of collaboration within three long term socio economic research (LTSER) projects conclude that the process of collaborative research was as important as the outcomes, and that such learning was “situated, ongoing, and incomplete”.

In this paper, we refer to the different incentives to collaborate coming from different professional cultures. We define cultures as distinct groupings with collective programming of the mind distinguishing the members of one group or category of people from another (Hofstede, 1996). Cultures of professions or organisations can be distinguished based on organizational forms, expectations, reward systems and organizational objectives, and less consciously applied values and social norms

¹Internationally through the development of the Long term Socio-ecological research programmes, in the EU with Framework 7 projects, in Australia, via the Australian Research Councils Research networks, in the US through the National Science Foundation funded Engineering Research Centres, and in UK through the Rural Economy and Land Use programme, UK National Ecosystem Assessment and LINK projects linking consortia of private sector organisations and researchers in the area of agricultural and environmental research, funded by the Department for Environment, Food and Rural Affairs.

(Schein, 2010; Hall, 2005; Davidson and Scholfield, 2002) In this paper we explore the role of professional cultures but recognise that cultures are also articulated in terms of ethnicity, organisation, and even academic disciplines, or a combination of these cultural spheres (Dietz *et al*, 2010).

While there may be incentives to work across these boundaries in terms of complementary competence, data or equipment, there are also many disincentives related to professional values and esteem (Hicks and Katz, 1996; Melin, 2000; van Rijnsoever and Hessels, 2010). Just as there are challenges in crossing ethnic boundaries and bridging “psychic distance” (Child, *et al*, 2002), there are challenges in transdisciplinary collaborations that cross professional cultural boundaries even when all parties have incentives to cooperate. Collaboration cannot be assumed to follow incentives and there is a need to examine the nature of relationships involved, and in particular the role of trust.

2.2 Building trust in transdisciplinary collaborative relationships

The process of bringing together organisations and working cultures from more diverse environmental and academic institutions broadens the challenges for collaboration. Some reflective studies have recognized the importance of institutional and interpersonal issues affecting research teams (Romero-Lankao *et al*, 2011). Research on landscape management and planning highlighted that trust was a vital ingredient in the collaborative process (Stenseke, 2009).

The process of building trust has received relatively little attention in the academic literature on research collaboration. Newell and Swan (2000) examine trust in university research networks and Bruneela *et al*. (2010) have shown how trust is important in university-industry relationships. This paper fills a gap in the literature by examining these relationships of trust in more depth. Trust is an expectation of others in a relationship. It occurs when there is an element of vulnerability and provides confidence in others even when there is a risk they will act opportunistically (Nooteboom, 1999). In terms of understanding collaborative research, there is a need to explore how trust is built up.

Zucker (1986: 60-65) has set out three “central modes of trust production”. In addition to institutional based trust (such as contracts or rules related to shared expectations from formal structures), she also refers to ‘*Process-based*’, where trust is tied to past or expected exchange such as in reputation and gift exchange; and *Characteristic-based*, where trust is tied to a person, depending on characteristics such as family background or ethnicity. Trust can also emerge from existing control measures such as formal contracts (Klein Woolthuis *et al*, 2005) or start with a ‘leap of faith’ (Mollering, 2006).

Inter-organisation relationships can also be shaped by trust in a third party or intermediary, and trust shaped on shared norms and business conventions. Individuals who can bridge different professional cultures play key roles as boundary spanners (Williams, 2002) who are able to communicate using appropriate language and cultural styles to mediate between different groups, facilitating communication and collaboration across disciplinary and cultural boundaries. Nooteboom (1999) refers to the go-betweens who help build trust and Yusuf (2008) refers to the various forms of intermediaries that play a ‘midwifery’ role for innovations.

The building of interpersonal trust is conceptualised as both calculation and actions shaped by institutions, routines and cultural norms (Mollering, 2006). Shared norms and organisational conventions support trust building. However, where trust is built

across professional boundaries, these culture specific values cannot be so easily drawn on. Research on the nature and formation of norms within professional cultures and within specific collaborative teams are restricted as they are intangible and difficult to observe. Norms define what actions are deemed to be right or wrong, and include customs of cooperation, reciprocity and interaction with strangers (Kreiner and Schultz, 1993; Lyon, 2006).

We will draw on these concepts underpinning collaboration in order to explore the processes and norms evident in the contrasting cases presented. This shows how policy is both shaping such collaborations and also making assumptions that need to be explored if policies are to be sensitive to the realities of collaboration and have a lasting impact.

3. Methodology

The empirical study takes a qualitative approach for theory building. From a sample frame of 53 research projects relating to environmental management in agro-ecosystems (collected from a survey of 15 academic, policy and practice key informants), ten case studies were selected. A purposeful selection process was used to ensure that the cases covered a range of different approaches to interaction, different degrees of collaboration and different types of professional cultures (from academia, NGOs, and private sector). Details of the case studies are shown in table 1.

Within each case study, detailed semi-structured interviews took place with between four and eight individuals having differing roles. A topic guide for the interviews was used to collect background information on the individual being interviewed and their organisation. Detailed probing questions were used to explore how they were going about their research and learning, their interaction with other stakeholders, and external factors that have shaped this. Interviews focused on their experiences in the specific collaborative project. Particular attention was given to exploring what happened at 'critical incidents' such as meetings to discuss the research objectives or results (Chell, 1998).

Each interview was carried out by both a natural and social scientist, with training provided to those who had not had experience of interviewing before. This process allowed greater insights during analysis into the different professional cultures and disciplinary approaches of stakeholders. The process of interviewing and data collection for this study therefore mirrored the issues facing respondents with the need to bridge the boundaries of professional cultures associated with the disciplines and social and natural science.

Cross case analysis allowed conclusions to be drawn (Yin, 2003). The microscopic details of the data was examined with careful analysis of comments and reactions of respondents such as the use of laughter and non-verbal responses to particular questions that show forms of tacit knowledge or gut reactions to particular issues (Ambrosini and Bowman, 2001).

While there is potential bias from the small sample and the role of the interviewers or data analysers, validity and accuracy was based on ensuring a range of techniques were used (interviewing, observations, informal discussions), combined with a sampling of cases allowing cross case comparison and the cross checking of issues from multiple sources ('triangulation').

Table 1 Details of the case studies of collaborative research on environment and land use.

Project	Description	Types of professional cultures involved
1. Home Farm Organic Study	Impact of organic farming on the environment	All academic university based (ecology, agronomy, social science), farming businesses
2. WildCRU on Chichester plains	Relationship of land use to water voles populations	Academics and not for profit Farming and Wildlife Advisory Group (advisory and pressure group), water engineers, farmers
3. Saffie (Sustainable Arable Farming for an Improved Environment)	Impact of farmers' conservation activities	Contract researchers, Not for profit pressure /membership groups, private technology development company scientist, university academics, agricultural advisers, farming businesses
4. Entry Level Scheme Environmental Stewardship	Evaluation policy to pay farmers for conservation	Contract research scientists responding to detail specification from DEFRA with not for profit membership organizations carrying out studies of specific topics
5. Nickersons/ Brown and Co and the Buster Club	Breeding new varieties of wheat	Commercial plant breeders, agricultural advisers, farming businesses
6. Wheat Blossom Midge	Developing treatments/resistance to this pest	Contract researchers lead the project with involvement of technology companies and minor roles of farming businesses
7. Unilever's Sustainable Farming Programme	Crop and agri-environmental trials on farms	Not for profit membership/pressure group and contract researchers commissioned to do studies, co-ordinated by an employee of Unilever and involving farm manager of Unilever farm
8. Nitrates leaching in organic farms	Measuring the extent of nitrates leaching on different farms	Researchers from contract research company, university, not for profit research centre with active involvement of farming businesses.
9. Animal welfare	Developing approaches to measure pig welfare	Researcher from Scottish Agricultural College and farming businesses
10. Biosecurity	Reducing disease risk in dairies	Researchers (veterinary and social science) from Reading University and from Scottish Agricultural College

4. Results

4.1 The incentives and disincentives to collaborate in environmental research

The selected case studies demonstrated different coalitions of researchers, NGOs and businesses, each of which was found to have different incentives to be involved and disincentives that had to be overcome. These incentives were found to vary according to the professional cultures of different types of participants. Analysis of their ownership and organisational form shows that these can be divided into six groups as shown in table 2.

Table 2 Incentives and disincentives to collaborate according to professional culture.

<i>Type of participant</i>	<i>Case study</i>	<i>Incentives reported</i>	<i>Disincentives reported</i>
Permanent academics	1,2,3,8,10	Interest in complex environmental problems Personal interest in influencing practice (once established as an academic) To win contracts for funding	Need for mono-disciplinary publications Partners may not aspire to same degree of rigour
Short-term contract academics (Post-docs Research associates)	1,2,9	To answer complex environmental problems Experience of working with environmental NGOs and other businesses. Access to funding	Progression to permanent job via academic publications within discipline Research not considered rigorous, especially when lack of control of variables
Environmental pressure groups / NGOs	2,3,4,6,7,8	To tackle environmental issues that are not within a single discipline Provide material for lobbying Dissemination to land users Access to funding	Environmental goals conflict with objectives of partners Responsibility to members Partners unwilling to release early results Academic results not available to users
Technology company (plant breeders, agrochemical companies)	3,5,6	Extend research and development where less capacity Obtain insights from customers Demonstrate support for customers Improve image and profile	Unwilling to share intellectual property Responsibility to shareholders Long time frame for academic research
Commercial consultancy and research companies	3,4,5,6,7,8	Use their links to researchers, technology companies and land users to get funding Get resources to generate knowledge of use of their customers	Protection of intellectual property
Farmers and land managers	1,2,3,5,7,8,9	Knowledge generation that helps Increase yield or improve land management Interdisciplinary approach mirrors their practice of balancing economic, environmental, social and technical perspectives	Formal trials and controlled variable experiments unlike actual practice Academic research not communicated to farmers Long time frames of academic research

Source: analysis of case study material

In a majority of cases the incentive for collaboration is knowledge exchange and to get ideas. One interviewee from a technology company involved in plant breeding stated: "I don't believe you get anywhere working in isolation or a vacuum and that openness is much more successful than having secretive research, so that it is important to be talking to people, sharing ideas, potentially they nick a few ideas but on the other hand you also build up good relationships and you find out things from them as well."

NGOs were interested in collaboration in order to generate evidence for lobbying. Knowledge generation through interdisciplinary research was found to be particularly attractive to farmers and business stakeholders as their work involved the balancing of economic, social and technical issues in the context of rapidly changing environmental and market conditions.

The private technology company scientists stated they benefited as they are able to be involved in research without employing a large number of researchers: "We're not rich enough to have lots of research workers in white coats, reinventing everything, so what we do is we come to agreements to work on specific projects in a collaborative way". Involvement was also seen as a way to 'get out of the office', or as good public relations.

However, personal relationships are still important, with individuals collaborating in order to develop networks that can be drawn on serendipitously in the future:

"Why does the company do it? Partly for the results, partly for the networking - in doing the research no matter what the results you get, you do get to know other people ... there is a spider's web of connections with other workers that has developed over the years.....when you have other queries or you need other information, you know who to contact and if you already know them you can just ring them up and say 'look I have got a little question for you, or can you point me in the right direction for this'.... you do not need to be an expert but you need to know someone who is and that networking provides him with the knowledge of those people who are." (Plant breeder in a technology company).

The most common motivation for carrying out research across disciplines and with farmers is the pressure or encouragement from public sector funding. This is observed in six of the ten case study projects. It is also interesting to note that in four of these cases, interviewees, particularly those from academic backgrounds, stated that they felt that the project was considered very different, or 'odd' compared to other more traditional mono-disciplinary research.

In one case study (Saffie) the commissioner of the research asked three bids to join together and develop a collaborative proposal. In another case study (on organic farming), three UK research councils funding work related to environmental land-use joined forces and demanded all bids from Universities involved a combination of disciplines. As one academic participant in this noted: "The project is historically interesting, since it represented the first attempt to get three research councils together to jointly fund an interdisciplinary research project. Thinking about interdisciplinarity was new in 1993, and there was no track record to fall back on". The research councils were keen to experiment in interdisciplinary research, with the effects of the research process shaping future programmes of these funders.

While there are a range of incentives, there are also disincentives to collaboration. These were found to differ between the varying professional cultures particularly when collaboration was at odds to existing norms, values and priorities. Analysis of the cases involving university researchers shows how the dominant goal of universities of conducting rigorous research which is published in peer-reviewed journals overrides the dissemination of results to non academic audiences. This can create conflict with those partners who want immediate results. Environmental NGOs in four of the case studies reported objectives and reward systems based on getting publicity and lobbying, as well as working with members or farmers. In contrast to the university academics, there is little emphasis amongst these organisations for peer

reviewed scientific publications unless they can be justified as way of making lobbying more influential. In one case, a NGO researcher stated: “We want to have publications with scientific credibility for lobbying; if you’ve got a refereed paper then you have a stronger case”. There are criticisms from other types of organisations concerning the speed at which they release results and the extent of scientific rigor. In one case a project partner from a commercial advisory company noted a particular incident when there was a disagreement between NGO and university researchers: “People have different ways to communicate. For example xxxx want to get the information on xxxx out very soon but then [university] scientists want data out in journals”

The NGO researcher in this case study reflected on this tension:

“Interviewer. Is there a difference in scientific rigour? ... (interviewee laughs) ... That's a very difficult question, I'm not sure I could really answer that one But some will come from the point of view of good science while others are more for a particular result. Perhaps they don't think so much about the statistical validity. It depends on the type of organisation they are and their cultures and their pressures.... But I must say through all these projects, none of the science is bad science.”

This demonstrates the tensions within collaborations when there are different norms related to scientific rigour or to communication of results.

4.2 The basis of trust in the collaborative research case studies.

Analysis of case studies shows that despite there being incentives for collaboration, challenges still need to be overcome. With such differing professional cultures, building relationships across boundaries entailed an element of risk and therefore required trust in other parties. When discussing the use of trust, respondents referred to the importance of having information on other collaborators. Knowledge was needed about their past behaviour and reputation (in terms of technical competence, honesty and organizational capacity). The ways in which different parties can obtain this information is discussed in the next section. However, it is not only the use of information on others that appears to affect trust building.

Sanctions and other controls are also important for having trust. In eight of the ten cases, there were formal contracts that held project partners to specific outputs and specific milestones. Other forms of contractual controls reported in the cases include the use of intellectual property agreements which limit partners’ ability to publish the results for two years and a formal publicity plan agreed by all partners. There were also informal sanctions, such as peer pressure. One researcher stated: “If they don’t pull their weight you can put pressure on them. We are a group and everyone wants a good project - that’s the pressure”. An interviewee in a commercial consultancy company stated: “there is this pressure from the whole of the consortium that if you don’t do the work it can be[pause] The people won’t work with you again and you have a bad reputation.”

However this contrasted with one incident where a project partner had broken an agreement regarding releasing results to the media. The other partners were not willing to confront them openly as this might jeopardize the rest of the project and damage the reputations of all project team members in the eyes of people outside the project. There are therefore norms that shape what forms of sanctions are appropriate and also norms that limit the ability to enforce sanctions.

4.3 Process of building trust

Building on existing relationships

The most common way of ensuring collaboration was through drawing on existing relationships. In such cases, each party had the opportunity to learn about how the other party works, their technical capability, and their values. Furthermore, through socializing they perceive they are able to put moral pressure on others. Many of the interviewees reflected on networks of researchers doing similar or complementary work, referring to it as a 'small community' where people know of others' work and approaches. While three respondents stressed that teams could work without prior experience, they recognized that it helps if "you know they can work together" and have shared positive experiences in the past. Through working with people known already, researchers can know they can draw on common understandings and norms of doing research and sharing projects. One contract researcher stated:

"there appears to be a Mafia of agricultural research, that might be how it appears to the outsiders but in order for a project to work you need a degree of mutual trust and respect if it is going to work and therefore you want people with whom you already have a track record of working".

Team changes can threaten the building of trust and this occurred in four of the projects; when someone died, where a partner dropped out as they were not able to do the work, where internal reorganisation meant people were moved away from the project and twice in cases of women taking maternity leave. One interviewee referred to this saying "I suppose you have that sort of noise in any system". In each of the cases, the project continued.

Existing relationships can change over time and be put under pressure when the degree of competition increases between partners. One technology company scientist identified the growing tension with other technology companies in the collaboration due to their company taking market share from their competitor.

Building trust through the project

In three of the case studies the collaborators had not worked together before but could build relationships through working together. One private sector farm adviser commented on new relationships:

"You need trust but it isn't any problem setting up new ones [collaborations]. With a big project like this and with several groups it does take time for ideas to shake down. We have different ways of working, different expectations and different ways of writing protocols. People come with their own interests but then over time the project identity comes as well...Everyone has to have trust so that they can work to the aims of the project."

Interviewees reported that trust was built through working together, openness and putting themselves at risk from others, discussing issues democratically, gaining understanding about others' disciplines and having clear and complementary roles. This form of trust building can strengthen existing ties or as one interviewee stated, it "firms up existing relationships".

Personalities of team members and power relations were also reported to be important factors by an academic: "It hinges on the individual – if you have a good working relationship with people then it's smooth but if someone dominates it – normally the older people – then its problems. (*Interviewer: Why is it the older people?*) They feel they know best about everything..... All the scientists sat around, it was pretty democratic I think and we're after good science at the end of the day. All the people there are post-doc and have the rigorous scientific approach. There was no-one there who was especially senior and trying to push work in their direction."

There can also be a blurring of the lines between working relationships and friendships, with norms of friendship being built up through working and socialising together. In the Home Farm Organic Study, the junior research staff from different disciplines and research organizations shared a house, which enabled them to develop friendships and trust in parallel with their professional relationships.

There is more opportunity for this in longer term projects, or with continued streams of funding for interdisciplinary research that allows teams to continue working together. For example the Saffie and Wheat Blossom Midge case studies involved members who had worked together on previous interdisciplinary projects. However, even after three years of working together on one project, one researcher still felt this was inadequate:

“The task of assembling an interdisciplinary team requires different budgets and timescales. 3-5 years is rubbish because the task requires a honeymoon integration period which is a job in itself. It does not happen overnight. In this case it was rank stupidity to stop after 3 years because we had just started”. Furthermore, through working together over time, common norms and values can become established in a new ‘hybrid’ professional culture.

Use of intermediaries and guarantors

In three of the cases (the Wheat Blossom Midge, Saffie and the Nitrates studies), the project teams were brought together by intermediaries trusted by the different parties. In each case these individuals had experience of working within both research and business cultures. Boundary spanners are particularly important when crossing professional cultural boundaries of research and farming businesses. Three types of research-business boundary spanners were identified: Private sector scientists who want to be close to their customers and understand their market (Nickerson’s plant breeding, Wheat Blossom Midge and Unilever); Scientists who have personal links with NGOs or farming, through personal interest or family background, giving them insights into norms and values of businesses; Specialist boundary spanners acting as advisers or consultants translating research into practical actions for businesses.

Those projects that have employed specific ‘boundary spanners’ from the start recognize the skills that are required and the time it can take building relationships. While involvement of these specialists can be beneficial, it was also noted that this division of responsibility can result in scientific researchers being even further removed and distant from farmers and land-users. However, advisors in two of the projects were also involved in advising on the design of the research because of their knowledge of what is practical in a commercial farm environment.

5. Discussion

The case study material shows that a challenge of transdisciplinary and interdisciplinary teams was found to be the maintenance of good relationships and trust. Our analysis shows successful collaboration requires not only incentives (often, but not exclusively related to policies of funding collaborative projects) but also trust based relationships.

Trust is required as there is reliance on others to meet and achieve outcomes. Secondly trust is required to ensure that individuals follow different norms regarding the use of the results (in press releases, publications or using Intellectual Property in future commercial activities). The varied norms and different values between cultures

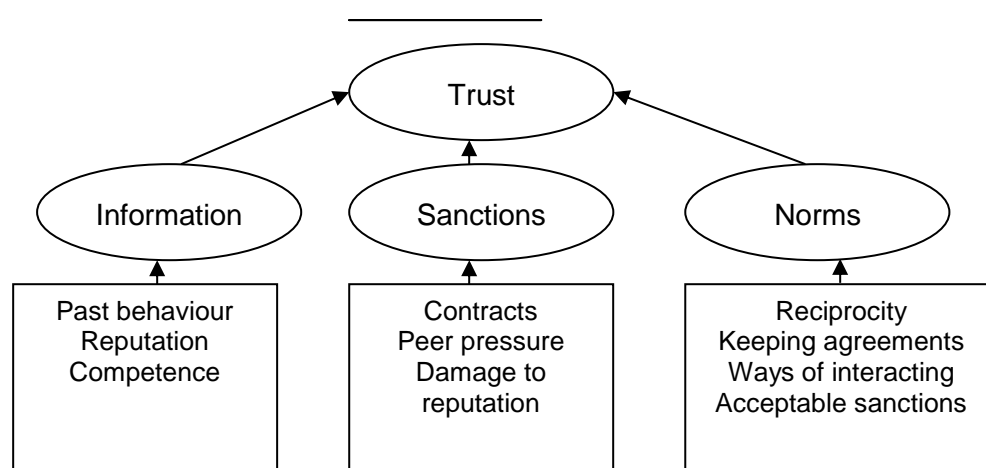
resulted in tensions, particularly with respect to perceptions of the quality of work, timing of publishing results, the order of names on a publication, and where work is disseminated.

While Broto *et al* (2009) refer to the professional costs and benefits of collaboration for different team members this paper investigates the incentives to collaborate in detail. These are shown to vary between the bottom up motivations (related to the needs of the organisation, or individual) and the top down (related to funding decisions and policy). Bottom up incentives include the desire for interdisciplinary research amongst commercial researchers who cannot justify the investment in large teams of researchers on their own. There is also recognition that collaboration may not be for immediate gain but to develop relationships that may lie unused until needed in the future.

While funders were identified as driving forces behind inter- and transdisciplinary research, they were also criticised as only having one-off programmes and short term projects that did not support ongoing investment in developing trust within collaborative research teams. Thus there is a tension within funding policy between long term collaboration and competitive bidding for short term research. There are further challenges of relying on the current peer review process using established researchers and academics to assess proposals. In five of the cases where there was majority of funding from the public sector, respondents felt that interdisciplinary and transdisciplinary proposals were penalised as they did not live up to the expectations of some reviewers coming from specific disciplines and very different traditions of doing research.

The second research question explores the role of trust and the basis of collaboration. While seven of the cases had some form of written collaborative agreement, they all considered other less formal relationships equally if not more important. A model of trust is demonstrated in Figure 1, based on elements of information on others, acceptable common norms of behaviour and sanctions on those that do not co-operate.

Figure 1. Trust production in the case studies



Source: authors' analysis of case studies

The cases show how trust is built on existing relationships, working relationships and different kinds of intermediaries. This supports previous research on trust building

(Zucker, 1984; Mollering, 2006). However, information alone on others is not enough. The analysis of the cases shows that norms of cooperation also shape how trust is used. While there are distinct profession-specific norms concerning how collaboration is carried out, there are some common norms that are found across the professional cultures studied. These include reciprocity (helping each other on specific problems and sharing knowledge), keeping to agreements and honesty (for example not publishing material without others' permission). Boundary spanners were found to play a key role in building trust across professional cultures. They commonly had experience linked to more than one professional culture and could draw on multiple identities and know how to build culturally specific relationships based on actions that are embedded in the social relations and norms of different professional cultures. These individuals were crucial to developing trust quickly.

The third element in Figure 1 is that of sanctions. Trust is not only based on norms of reciprocity, but also on control. Examples of these controls include formal written contracts, but most importantly peer pressure. There are also norms that shape what forms of sanctions are appropriate and norms that limit the ability to exert sanctions.

6. Conclusion

This paper has shown the challenges of bringing collaborative teams together, but within the topic of environmental sustainability from which these cases are selected, such collaboration and crossing of professional boundaries has never been so pressing. In a new research era of "post-normal science" (Ravetz, 2004), more voices are contributing to debates about priorities for research and this has led to interesting new collaborations and partnerships in research. The challenge is to break through the norms of monodisciplinary work and to understand how diverse teams can be built up and sustained. Through understanding the issues of trust and power in a range of contrasting collaborative research teams, this paper contributes to understanding how collaboration in projects operates in practice and how it can be understood.

There is a growing demand for collaboration by public, private and not for profit sector funders. These may need to cross disciplinary and other cultural boundaries that exist between different types of organisations and recognise relationships which shape research collaborations. Broto *et al.* (2009) show how the assemblage of a team is vital for interdisciplinary environmental research and this study shows that the investment required to develop and establish effective inter and trans-disciplinary teams is lost without continuity in further projects. Trust is a vital ingredient in collaborative research and this paper has shown how collaborating across professional cultures presents particular challenges. Trust is particularly important when relationships come under pressure such as when the results are negative for one partner. Trust can be supported through transparency and the use of boundary spanners who can create bridges between those of different professional and disciplinary cultures. The policy context for commissioning research can be more sensitive to the process of building collaboration. Recognition of existing trust based relationships in teams bidding for research is important although this should not be at the expense of encouraging new configurations of perspectives and disciplines.

This paper shows how trust is based not only on norms and having information on others, but also on sanctions or controls. Development of trust is shown to take time, requiring all parties to open themselves to vulnerability but avoid exploitation. These relationships can then be used in the future in other research projects. We show how it is necessary to understand the processes of research collaboration and trust building that go beyond having a motivation. There is a need to understand the social

institutions and norms behind collaboration so that effective policies (such as allocation of funding) can be promoted that support collaboration in research where it may be beneficial.

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